

Name :

Roll No. :

Invigilator's Signature :

CS/B.Tech (EIE) / SEM-4 / EI-403/2010

2010

INDUSTRIAL INSTRUMENTATION – I

Time Allotted : 3 Hours

Full Marks : 70

The figures in the margin indicate full marks.

*Candidates are required to give their answers in their own words
as far as practicable.*

GROUP - A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any ten of the following :

$$10 \times 1 = 10$$

i) Sensitivity of a voltmeter is expressed in

- a) volt/ohm
- b) ohm/volt
- c) ohm.volt
- d) siemen/volt.

ii) For fast dynamic measurement, suitable transducer is

- a) LVDT
- b) Strain gauge
- c) Selsyn
- d) Capacitance transducer.

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iii) The ratio of the measurement at full scale to the power drawn by the instrument is called

- a) Efficiency**
- b) Fidelity**
- c) Precision**
- d) Sensitivity.**

iv) Which of the following statements is true for a measuring instrument ?

- a) If it is precise, it is accurate**
- b) If it is linear, it is sensitive**
- c) If it has a digital display, it is accurate**
- d) If it uses null balance technique, it has a high input impedance.**

v) The instrumental error of an instrument is classified as

- a) Gross error**
- b) Systematic error**
- c) Random error**
- d) Indefinite error.**

vi) Transducer for measurement of rotational displacement is

- a) Shaft encoder**
- b) Differential capacitor**
- c) LVDT**
- d) Strain gauge.**

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vii) The conformity of the output to the true value of the measurement is called

- a) Precision
- b) Accuracy
- c) Sensitivity
- d) Resolution.

viii) A 0 – 300 V voltmeter has an error of $\pm 2\%$ of full scale deflection. What would be the range of readings if true voltage is 30 V ?

- a) 24 V to 36 V
- b) 29.4 V to 30.6 V
- c) 20 V to 40 V
- d) 30 V to 60 V.

ix) Stroboscope is a transducer, which measures

- a) strain
- b) force
- c) angular velocity
- d) both (a) and (b).

x) In semiconductor strain gauges, the change in resistance on application of strain is mainly on account of change in

- a) length of wire
- b) diameter of wire
- c) resistivity
- d) both (a) and (b).

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xii) A load cell is an electromechanical device widely used for measurement of

- a) static force**
- b) dynamic force**
- c) both static and dynamic force**
- d) temperature.**

xiii) A bolometer is an element that

- a) senses thermal output**
- b) senses optical input & gives thermal output**
- c) senses optical input & gives electrical output**
- d) senses electrical input & gives optical output.**

**GROUP - B
(Short Answer Type Questions)**

Answer any three of the following. $3 \times 5 = 15$

- 2. Briefly explain with proper diagram, the operating principle of pneumatic force-balance system with flapper & nozzle.**
- 3. Define Reliability of an instrument. If 200 faults were recorded for 400 transducers of a system during 2 years, the mean down time being 2 days, what are the MTBF & mean failure rate of the system ?**
- 4. With neat sketch, describe the working principle of seismic transducer for displacement measurement.**

1 + 4

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5. Discuss the basic scheme of an intrinsically safe electronic system to work in hazardous area.
6. Discuss in brief the principle of proxy brake to measure the torque.

GROUP - C

(Long Answer Type Questions)

Answer any three of the following. $3 \times 15 = 45$

7. a) What is a strain gauge ? How is it classified ?
b) Deduce the expression for the gauge factor of a strain gauge : $G = 1 + 2\mu(\Delta\rho/\rho)/(\Delta l/l)$ where G = gauge factor, μ = Poisson's ratio & $(\Delta\rho/\rho)/(\Delta l/l)$ = change in resistance due to piezo-resistive change.
c) A strain gauge with a gauge factor of 2 is fastened to a metallic member subjected to a stress of 1000 kg/cm^2 . The modulus of elasticity of the metal is $2 \times 10^6 \text{ kg/cm}^2$. Calculate the change in % in resistance of the strain gauge. What is the value of Poisson ratio ?

$2 + 2 + 5 + 3 + 3$

8. a) What are load cells ? Describe magneto-elastic load cell & strain gauge type load cell. How do they differ in operation ?
b) Explain the working principle, advantage & disadvantage of electronic load cell.

$4 + 5 + 2 + 4$

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9. a) Why is current signal preferred to transmit instead of voltage signal ?
- b) Why is 4 – 20 mA preferred as standardized signal for a transmitter? Explain the basic scheme of 2-wire & 4-wire transmitters.
- c) What is live zero in a 2-wire transmitter ? How is it advantageous ?
- d) What are the possible advantages & disadvantages of a pneumatic transmitter over electronic transmitter ?

3 + 4 + 3 + 2 + 3

10. a) Differentiate between accuracy & precision.
- b) What is the percentage error in measurement of kinetic energy of a body if percentage errors in the measurement of mass & velocity are 2% & 3% respectively ?
- c) The following table gives the variation of resistance with temperature for RTD :

Temperature °C	15	18	21	24	26.5	29.5	33
Resistance Ω	106.06	107.14	108.22	109.3	110.38	111.46	112.75

Find the linear approximation of the above resistance-temperature curve for temperature variation between 15° C & 35° C.

3 + 5 + 7

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11. a) What is bathtub curve ? Describe it.
- b) Why is it important in the analysis of a component ?
- c) What is availability ? How is it related to MTBF & MTTR ?
- d) What is meant by 5-nines availability ?
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